

Salmonella

Mehrdad Tajkarimi
DVM PhD
University of California-Davis

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Introduction

- *Salmonella*, major cause of bacterial foodborne diarrhea worldwide
- 1.4 million infections of non-typhoidal *Salmonella* in US each year
- 100% more fatalities between 1993-2003
- Crucial zoonotic agents in the veterinary field

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History

- Water and milk, vehicles of enteric fever, 1874
- *S. Typhi*, enormous problem in the US, before World War II
- Non-typhoid *Salmonella* infections may have peaked near 1990

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Salmonella infections

- Typhoid fever:
 - Caused by *Salmonella enterica* serotype Typhi
 - Human-specific
 - Human fecal contamination of food or water

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Salmonella infections

- Enteric fever — *S. Paratyphi* A
 - *S. paratyphi* B (renamed *S. Schottmuelleri*)
 - *S. paratyphi* C (renamed *S. Hirshfeldii*)

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Salmonella infections

- Gastroenteritis syndrome, all other types of *Salmonella*
- >2400 serotypes of *Salmonella*
- 150 of them have been associated with human disease

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Overall symptoms of *Salmonella* infection

- Nausea and vomiting for a few hours followed by abdominal pain and diarrhea
- Sometimes fever

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Overall symptoms of *Salmonella* infection

- Caused by invasion of intestinal mucosal cells, organism grows inside fixed macrophages
- Immuno compromised may get systemic infections
- Arthritis / Reuters syndrome (3 – 4 weeks)

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Infective dose in man and animals

- Day old chicks 1 – 5 cells
- Four week old 100 – 1,000
- Adult hens $\geq 10,000$
- 50 – 60 lb pigs $\geq 10,000$
- Human infants ≤ 100
- Adult human male $\geq 100,000$

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Salmonella contamination

- Most human *Salmonella* outbreaks, consumption, products of animal origin
- Infection in humans may be transmitted during contact with animals, contaminated water, or the environment

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Salmonella transfer

- *S. Enteritidis* isolated from a sick child kill up to 50% of wild rat populations
- 26% of wild rats, *S. Enteritidis* and/or *S. Typhimurium*
- Samples collected in five states, *Salmonella* isolates from 4.7% of all samples.



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Classification of *Salmonella*

- Family Enterobacteriaceae
- Genus *Salmonella*
- Two Species:
 1. *Salmonella enterica*
 2. *Salmonella bongori*



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Classification of *Salmonella*

- Serotyping based on three cell-surface antigens:
 1. The O, or cell-wall (somatic) antigen,
 2. The H, or flagellar antigen, &
 3. The Vi (outer polysaccharide layer) antigen

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Characteristics of *Salmonella*

- Gram negative
- Aerobic or facultative anaerobic
- Motile or non-motile
- Non-spore forming rods
- Catalase positive and oxidase negative

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Characteristics of *Salmonella*

- Has 90% DNA homology with *E. coli*
- Little or no correlation between serotype and clinical signs and symptoms
- pH values are between 4 and 9

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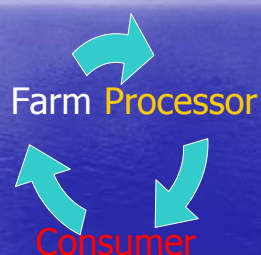
Growth of *Salmonella*

- Optimum water activity is 0.96 – 0.999.
- Oxidation-reduction (OR) potential: little effect on growth or survival of microorganism.
- The growth temperature between 5 – 45°C with an optimum growth temperature of 35 – 37°C.



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Survival of *Salmonella*(1)

- *Salmonella* can be killed by repeated freezing and thawing cycles, food quality?!!!
- Heating can kill *Salmonella*



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Survival of *Salmonella*(2)

- *Salmonella* is more resistant in egg yolk than in white.
- It is highly resistant in dry foods and foods rich in fat.
- In milk chocolate with less than 2% moisture the *D* value is 222 min (3.7 h) at 80°C.



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Detection of *Salmonella*(1)

- Non-selective pre-enrichment, lactose broth, buffered peptone, etc.
- Selective enrichment to inhibit other bacteria: Tetrathionate, Selenite cystine, Rappaport-Vasiliadis (Malachite green)



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Detection of *Salmonella*(2)

- Differential selective agar media to select and identify *Salmonella*: brilliant green novobiocin, XLT4, bismuth sulfite
- Biochemical confirmation
- Serology
- Rapid Methods
- Immunoassay
- Gene probes, PCR, and electrical measurements, conductance



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Transmission

- Fecal material
- Person-to-person contact
- Contact with animals (e.g., pets)
CDC estimated that about 280,000 cases of *Salmonella* annually were linked to pet turtles
- Aerosols — although very unlikely



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Competition against other microorganisms

- *Salmonella* has short lag phase and can grow rapidly.
- Intestinal flora of adult hens is inhibitory: "competitive exclusion"
- 5% of *Salmonella* strains produce bacteriocins against *E. coli*, *Shigella* or *Salmonella*



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Prevalence of *Salmonella*

- The prevalence of *Salmonella* in humans in the USA is about 0.1%
- The prevalence in animals is generally higher, between 0 and 30%



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Control of *Salmonella*

- Poultry products
- Post harvest control
 - Control of scalding temperature between 50°C and 60°C
 - Control of defeathering, evisceration, system hygiene
 - Improvement of rinse chill system



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Control of *Salmonella*

- Shell eggs
- Post harvest control
 - Heat, irradiation,
 - Whole egg pasteurization at 60.0°C for 3.5 minutes — **expensive**
 - Irradiation (3 kGy)



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Control of *Salmonella*

- *Salmonella* presence in fresh fruits and vegetables
 - Contamination: production, harvest, initial processing and packaging, distribution and final processing
 - Contaminated water, a particular source, chlorination of water, a critical issue



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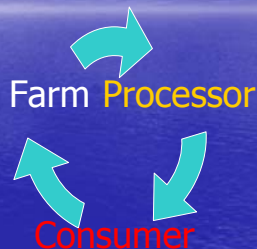
Summary(1)

- *Salmonella*, major cause of bacterial foodborne diarrhea worldwide
- Non-typhoid *Salmonella* infections may have peaked near 1990



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Summary(2)



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Thank you !

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